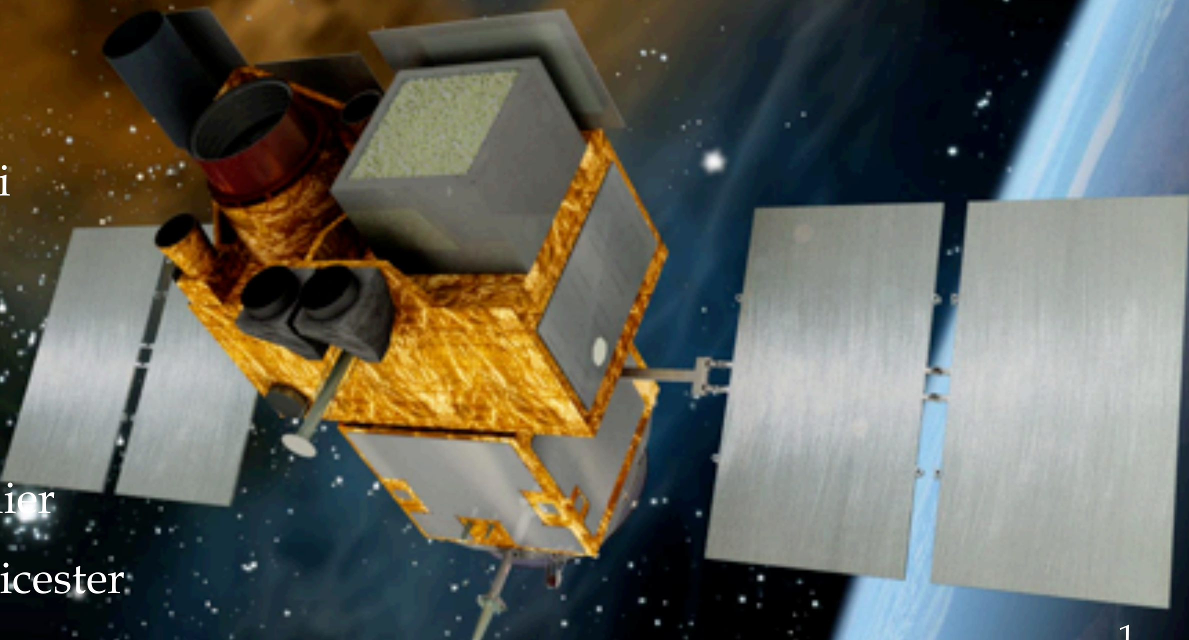
The SVOM mission

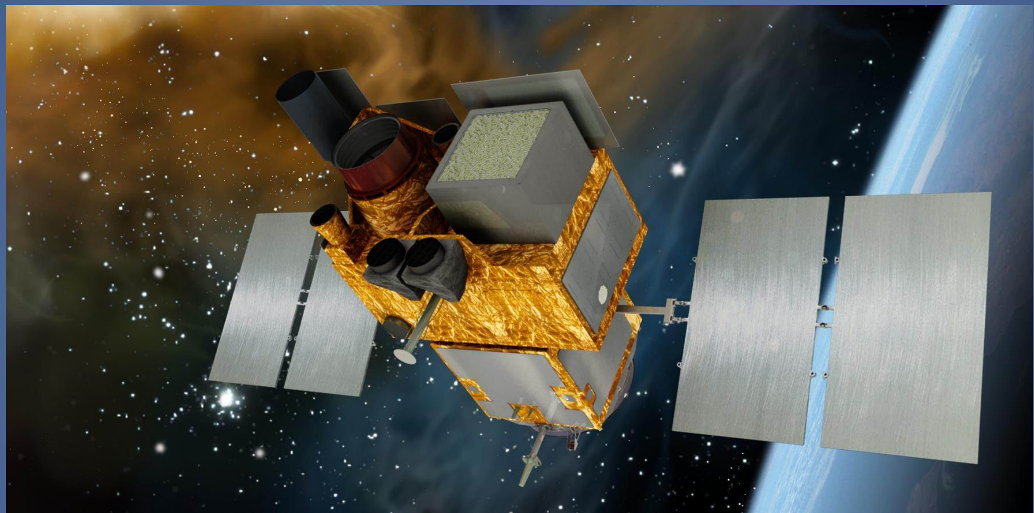
Cordier Bertrand CEA-Saclay
Wei Jianyan NAOC-Beijing
On behalf of the SVOM consortium



NAOC, Beijing	IHEP, Beijing
XIOPM, Xi'an	SECM, Shanghai
CEA-Irfu, Saclay	IRAP, Toulouse
APC, Paris	IAP, Paris
LAM, Marseille	LAL Orsay
CPPM Marseille	LUPM Montpellier
GEPI meudon	University of Leicester
MPE, Garching	CNES, Toulouse

SVOM in context

- **SVOM** = **S**pace-based multiband astronomical **V**ariable **O**bjects **M**onitor



- SVOM is a **Chinese-French** space mission dedicated to the detection and study of **Gamma Ray Bursts** and their use for astrophysics and cosmology.

- SVOM is planned to be launched early in the next decade **(2021)**, for a 3 year nominal mission.

Scientific rationale of the SVOM mission

- ***GRB phenomenon***
  - Diversity and unity of GRBs
- ***GRB physics***
  - Acceleration and nature of the relativistic jet
  - Radiation processes
  - The early afterglow and the reverse shock
- ***GRB progenitors***
  - The GRB-supernova connection
  - Short GRB progenitors
- ***Cosmology***
  - Cosmological lighthouses (absorption systems)
  - Host galaxies
  - Tracing star formation
  - Re-ionization of the universe
  - Cosmological parameters
- ***Fundamental Physics***
  - Origin of High-Energy Cosmic Rays
  - Probing Lorentz invariance
  - Short GRBs and gravitational waves

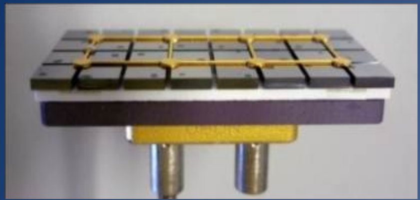
SVOM in context at the beginning of the next decade

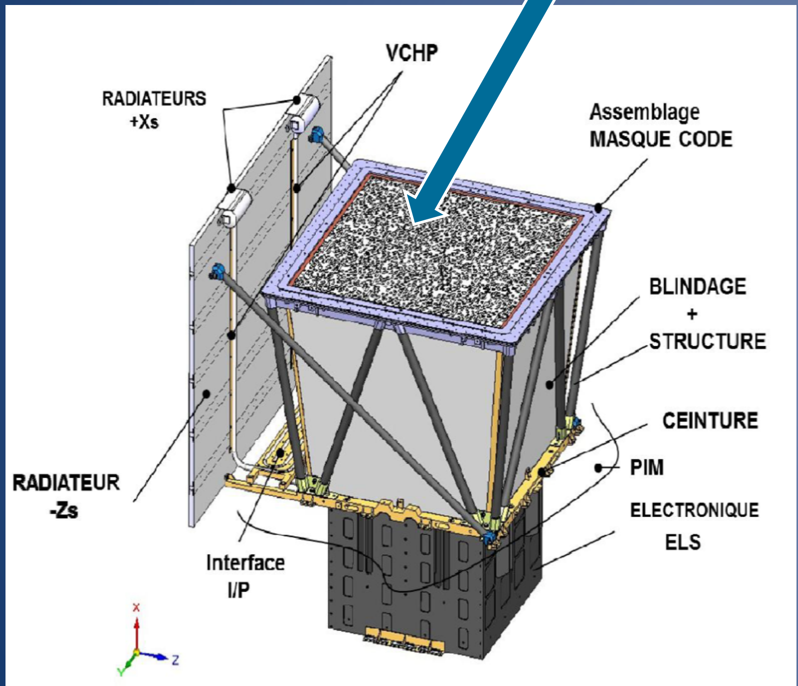
- SVOM is mini-satellite class mission (< 1000kg)
- SVOM will provide ~80 GRB/yr. It will explore the area of soft GRBs and X-ray Flashes (above 4 keV), and the prompt optical emission with a good sensitivity.
- We aim at measuring the redshift of >50% of SVOM GRBs
- SVOM will operate in the era of advanced GW detectors, providing the opportunity to search for correlations between GW and GRBs
- SVOM GRBs will benefit from follow-up with a new generation of astronomical instruments: JWST, SKA, CTA, LSST, etc.

SVOM scientific instrument arrangement

Satellite ~ 930 Kg
Payload ~ 350 kg

In space : ECLAIRs – The trigger camera





Main characteristics

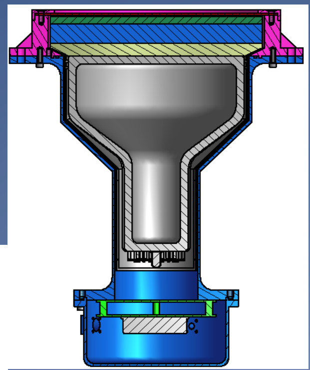
Coded mask telescope
Wide FOV : 2 Sr
6400 CdTe - 1024 cm²
4 keV – 150 keV

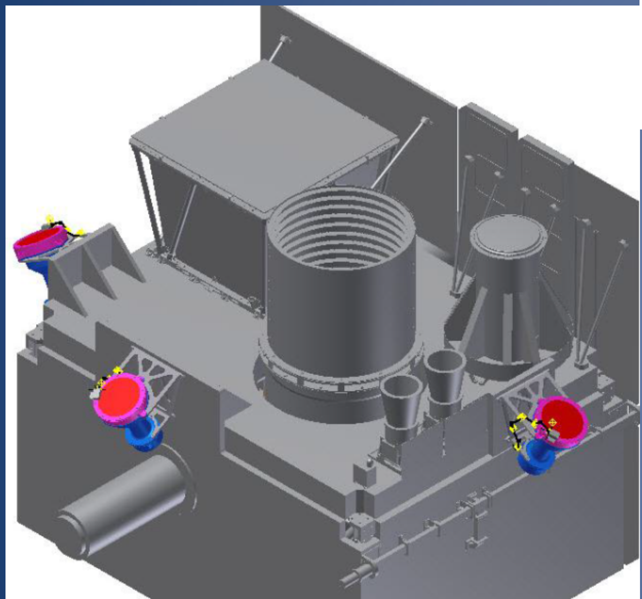
Anticipated performances

Loc. accuracy < 16 arcmin
4 arcmin for bright bursts
80 GRBs / year

Change of the coded mask pattern to enhance the sensitivity, but with a larger location error box . ⇨ See Posters : The ECLAIRs telescope Schanne et al.
The ECLAIRs trigger Antier et al.

In space : GRM – The Gamma Ray Monitor





Main characteristics

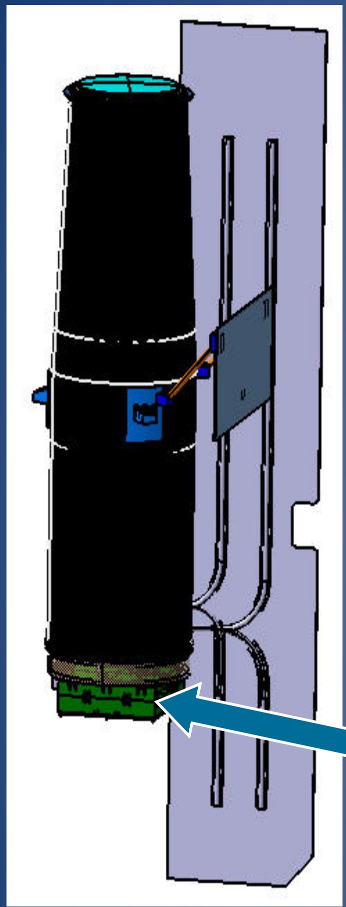
3 NaI detectors, 200 cm^2 each
Thickness 1,5 cm
FOV : 3x2 sr
15 keV – 5 MeV

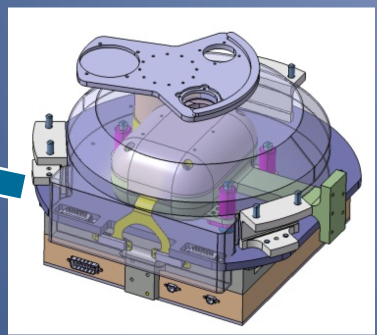
Anticipated performances

Loc. accuracy ~ 15 x15°(in 2.6 sr)
110 GRBs/yr

Enlargement of the FoV to enhance the detection rate of short bursts (which are expected to be candidate sources of GW bursts)

In space : MXT – The Multi-channel X-ray Telescope





Main characteristics

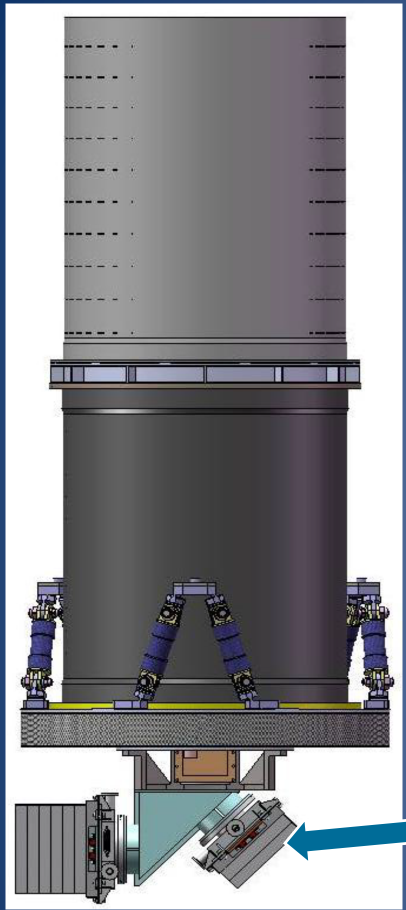
MCP "Lobster eyes" X-ray optic
FOV ~ 1 deg^2
256 x256 PN CCD
0.2 keV – 10 keV

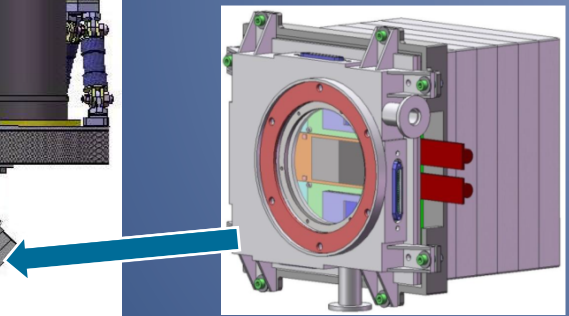
Anticipated performances

~50 cm^2 at 1 keV
Loc. accuracy < 1 arcmin
20 arcsec for bright GRB
~ 70 GRBs/yr

See Poster : The MXT telescope , Götz et al

In Space : VT – The Visible Telescope





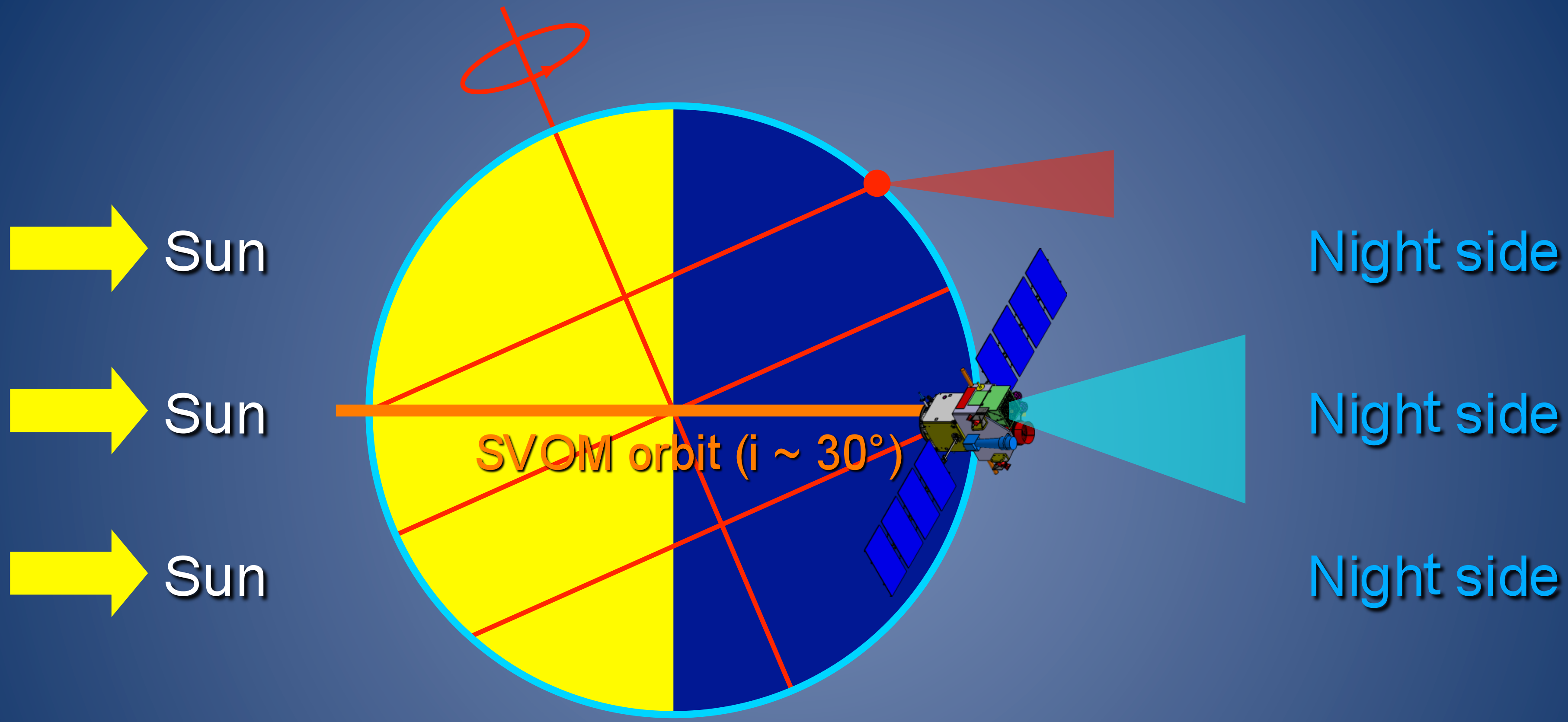
Main characteristics

Ritchey Chretien Φ =40cm
FOV : 26 x 26 arcmin^2
2 X 2048x2048 CCD
400 nm – 650 nm
650 nm – 950 nm

Anticipated performances

Fine Guidance System
Loc. accuracy < 2 arcsec
Mv = 22.5 in 300s
~ 60 GRBs/yr

SVOM Orbit



inclination 30°, altitude 625 km, launched by a LM-2C from Xichang

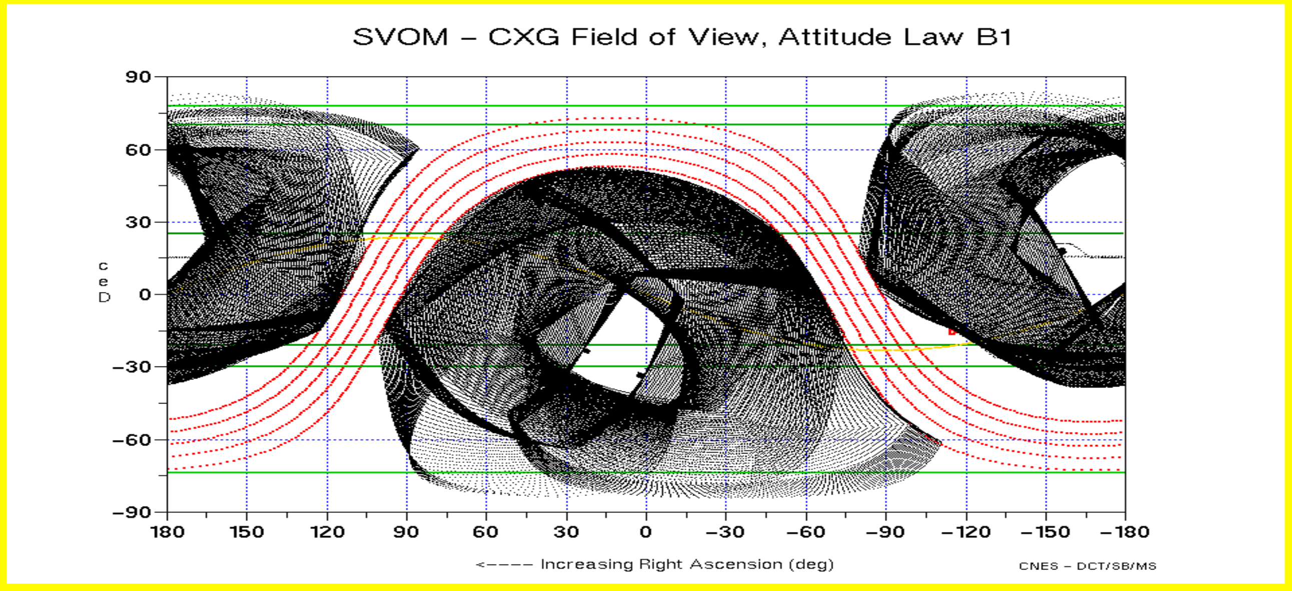
Attitude law : roughly antisolar

SVOM attitude law

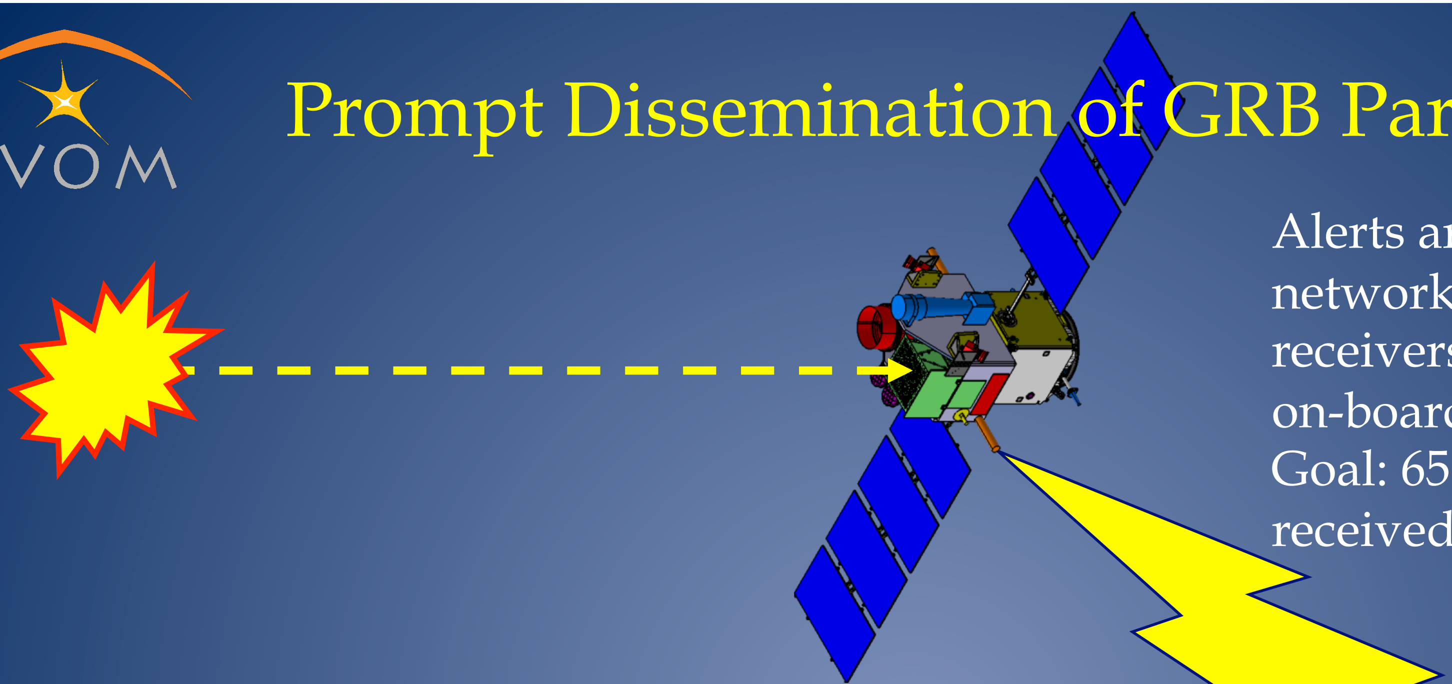
Objective: Most of the GRBs (up to 75-80%) detected by SVOM to be well above the horizon of large ground based telescopes, all located at tropical latitudes

Solution: the attitude law (optimization at system level)

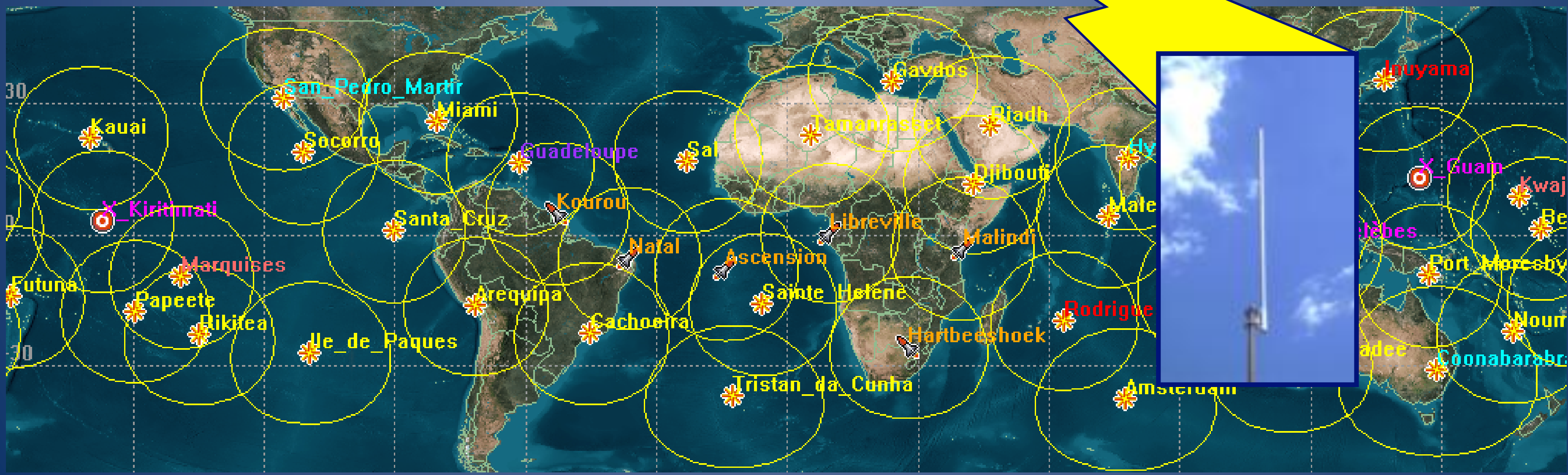
- Offset of 45° with respect to the antisolar direction
- Avoidance of the Galactic Plane (+/- 10° from the edge of ECLAIRs FOV)
- Avoidance of the Sco X1 source (outside the ECLAIRs FOV)
- If possible, edge of the ECLAIRs FOV at low latitudes
- Tolerance of 5° with respect to the nominal pointing



Prompt Dissemination of GRB Parameters



Alerts are transmitted to a network of 30-40 VHF receivers on Earth by the on-board VHF emitter. Goal: 65% of the alerts received within 30 sec



If you are interested to host a VHF station, please register at : http://hosting.svom.fr/

GWAC – The Ground Wide Angle Cameras

By following up half the FOV of ECLAIRs, GWACs will explore the realm of the prompt optical emission

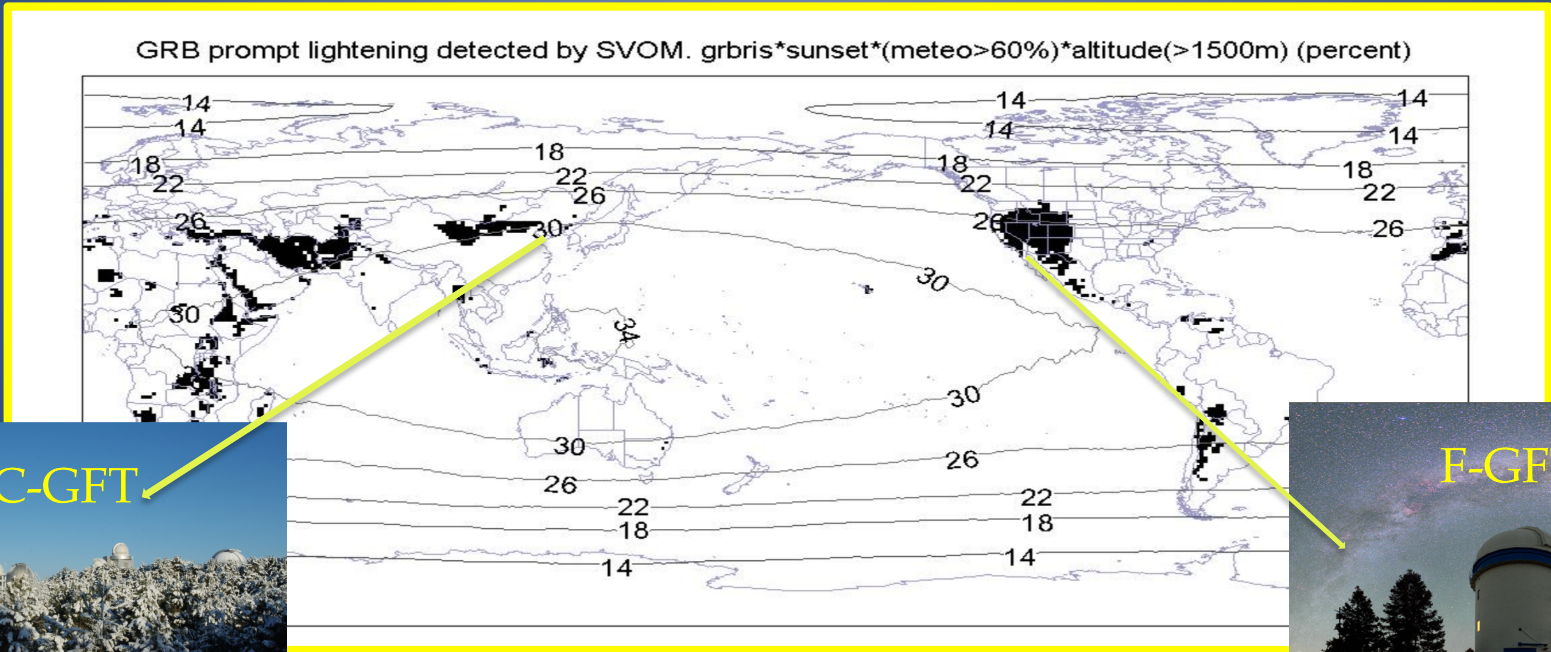
- **Cameras：** **36**
- **Diameter：** **180mm**
- **Focal Length：** **213mm**
- **Wavelength：** **500－800nm**
- **Total FoV：** **5000Sq.deg**
- **Limiting Mag：** **16.0V（5σ，10sec）**
- **Self Trigger:** **<15sec**

One subsystem in China, one subsystem in Chile (under discussion)

GFTs: Two Ground-based Follow-up Telescopes

GFTs permit the fast identification and measure of early optical/NIR afterglows (light-curve, SED) from the ECLAIRs positions, while the spacecraft is slewing to the source.

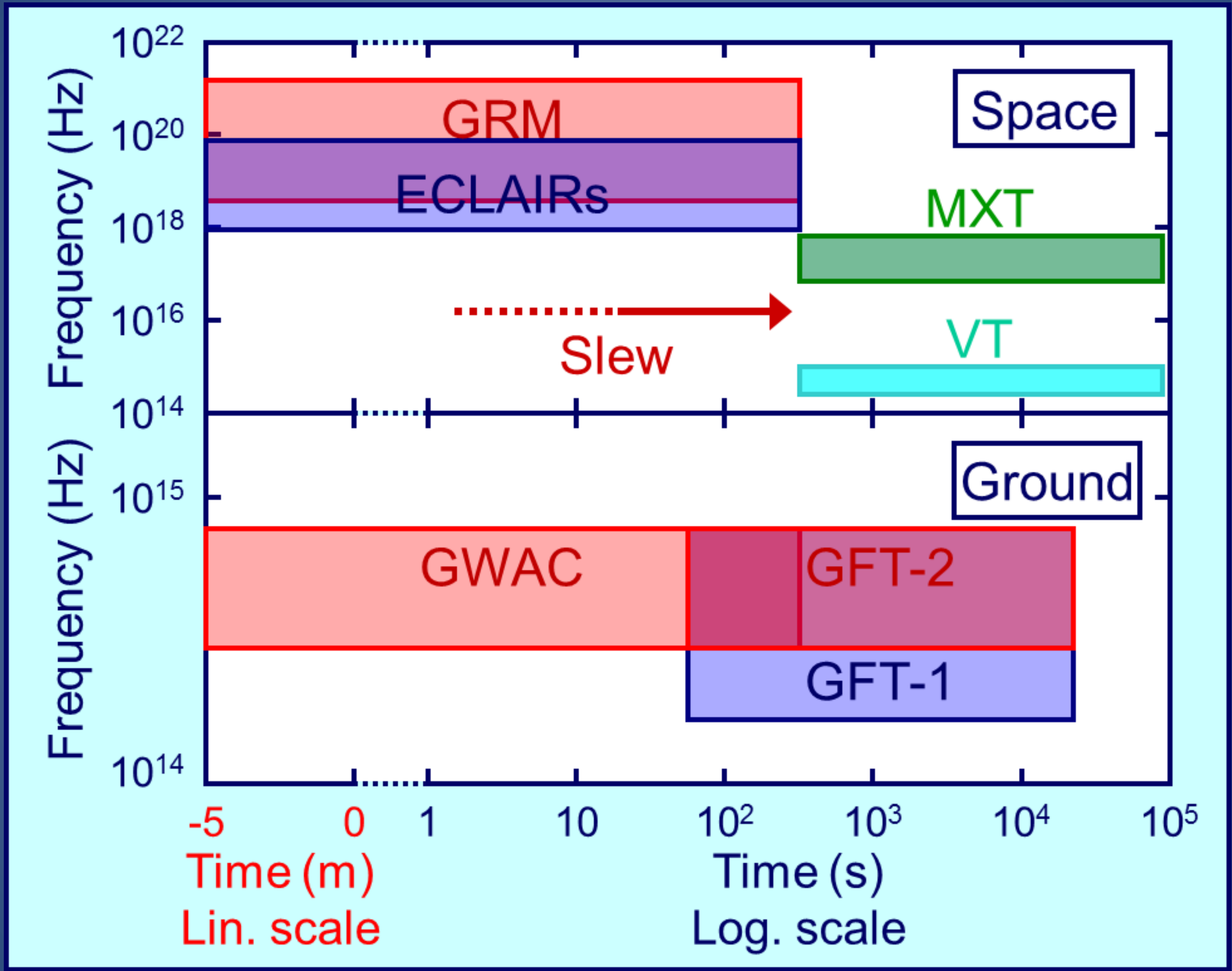
- C-GFT is located at Xinglong observatory (China)
- F-GFT will be located at San Pedro Martir (Mexico)



Diameter : 100 cm
FOV : 25 arcmin x 25 arcmin
400 – 1000 nm (1700 nm TBC)

Diameter : 100 cm
FOV : 30 arcmin x 30 arcmin
400 – 1700 nm

SVOM multi-wavelength capabilities



Space and ground instruments join to enable a unique coverage

SVOM unique capabilities for GRB studies

- Low energy threshold at 4 keV to detect soft GRBs
- Measure of GRB prompt emission over 6 decades in energy, from 1 to ~10^6 eV.
- Good sensitivity to short GRBs with GRM and ECLAIRs (soft bump)
- Many consecutive orbits with the same pointing, allowing the detection of hour long transients, like the 15000 sec long GRB 111209A at z=0.677
- Good sensitivity of VT, providing accurate GRB positions for >70% of the bursts. Dedicated NIR & vis. ground follow-up telescopes increase this fraction to >80%
- Large fraction of the afterglows seen by both MXT and VT.
- GRBs well located for ground-based follow-up

SVOM and highly redshifted GRBs
at the beginning of the next decade

- We expect to detect ~5 GRBs/yr at redshift z>5 with ECLAIRs.
- We aim to quickly identify high-z GRBs, thanks to the pointing strategy of SVOM, the sensitivity of VT, and fast NIR follow-up on the ground.
- This strategy will permit to set up an efficient Follow-up Program performing the optical spectroscopy of most of highly redshifted afterglows, allowing crucial scientific studies.
- Highly redshifted GRBs allow studying the young universe:
  - Gas and dust in young galaxies
  - Reionization of the IGM → GRB II session, Wednesday
  - Star formation rate
  - Search for GRBs from Population III stars (challenging)
    (rare, energetic, possibly very long like GRB111209A, with no detectable host)

SVOM and Gravity Waves
at the beginning of the next decade

- Coordinated searches of GWs and short GRBs may confirm or dismiss the favorite scenario for short GRBs: the coalescence of two compact objects
- From 2023 the Size of the GW error boxes will be several degrees^2
- **Coincident events:** within the horizon of GW detectors (~400 Mpc),

with assumption of 50 BNS/yr, we expect in 5 years of operation.

~3 events in ECLAIRs FOV

~9 events in GRM FOV

- **Follow-up:** within the same assumptions, we expect ~15 events in 5 years of operation that can be followed quickly with SVOM instruments, and particularly with the MXT (<6hours) and with the GWACs

Conclusions

- SVOM is the inheritor of Swift. We tried to optimize the SVOM mission thanks to the Swift scientific return

- SVOM, like Swift, will be a highly versatile astronomy satellite, with built-in multi-wavelength capabilities, autonomous repointing and dedicated ground follow-up.

- SVOM will have a broad science return thanks to its unique instrumental combination of 3 wide-field instruments: ECLAIRs, GRM, GWAC, and 3 narrow-field instruments: MXT, VT, GFTs.

- SVOM has the possibility to detect and localize short GRBs associated to GW events, even if it is challenging. Such a detection would represent the "holy grail" of GW astronomy.


NAOC, Beijing
IHEP, Beijing
XIOPM, Xi'an
SECM, Shanghai
CEA-Irfu, Saclay
IRAP, Toulouse
APC, Paris
IAP, Paris
LAM, Marseille
Obs Strasbourg
LPAG Grenoble
LUPM Montpellier
LAL Orsay
GEPI Meudon
LPC2E Orléans
University of Leicester
MPE, Garching
CNES, Toulouse
GO SVOM !
launch 2021
Phase B kick-off September 2014
cnes

SVOM Compared to SWIFT

Prompt emission measurement

- More sensitive below 20-30 keV
- Peak energy measurement capability
- Multi-wavelength capabilities from visible band to MeV gamma rays

Afterglow emission measurement

- > 10 more sensitive in the visible
- Sensitive in the 650-950 nm band

Follow-up observations

- Dedicated follow-up robotic telescopes
- GRBs much easily scrutinized by the largest telescopes

Follow-up observations

- Instrument with large FOV sensitive around 500 keV
- X-ray telescope with larger FOV
- SVOM will operate in the era of advanced GW detectors

At the beginning of next decade, SVOM will be the ‘proud’ successor of SWIFT